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ADDRESS OF THE PRESIDENT TO THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

MAN AS A GEOGRAPHICAL AGENCY

IN an inaugural address to the Royal Scottish Geographical Society on Geography and Statecraft Lord Milner said: "If I have no right to call myself a geographer, I am at least a firm believer in the value of geographical studies." I wish to echo these words. I have no expert geographical knowledge, and am wholly unversed in science, but I am emboldened to try and say a few words because of my profound belief in the value of geographical studies. I believe in their value partly on general grounds, and largely because a study of the British empire leads an Englishman, whether born in England or in Australia, to the inevitable conclusion that statecraft in the past would have been better, if there had been more accurate knowledge of geography. This statement might be illustrated by various anecdotes, some true, not a few apocryphal; but anecdotes do not lend themselves to the advancement of science. I am encouraged, too, to speak because the field of geography is more open to the man in the street than are the sciences more strictly so-called. It is a *graphy*, not a *logy*. Geology is the science of the earth. Geography is a description of the face of the earth and of what is on or under it, a series of pictures with appropriate letterpress and with more or less appropriate morals to adorn the tale. The man in the street may talk affably and even intelligently about the face of the earth.

[1] Australia, 1914.

Taking the earth as it is, geographical discovery has well-nigh reached its limit. The truth, in the words of Addison's hymn, is now "spread from Pole to Pole," and recent exploration at the South Pole, with its tale of heroism, will have specially appealed to the citizens of this southern land. Coasts are in most cases accurately known. The age of Cook and Flinders is past. Interiors are more or less known. In Africa there is no more room for Livingstones, Spekes, Burtons and Stanleys. In Australia Sir John Forrest is an honored survival of the exploring age—the age of McDouall Stuart and other heroes of Australian discovery. The old map-makers, in Swift's well-known lines, "o'er unhabitable downs placed elephants for want of towns." Towns have now taken the place of elephants and of kangaroos. Much, no doubt, still remains to be done. The known will be made far better known; maps will be rectified; many great inland tracts in Australia and elsewhere will be, as they are now being, scientifically surveyed; corners of the earth only penetrated now will be swept and garnished. But as we stand to-day, broadly speaking, there are few more lands and seas to conquer. Discovery pure and simple is passing away.

But meanwhile there is one side of geography which is coming more and more to the front, bringing it more than ever within the scope of the British Association for the Advancement of Science. "Man is the ultimate term in the geographical problem," said Dr. Scott Keltie some years since at the meeting at Toronto. "Geography is a description of the earth as it is, in relation to man," said Sir Clements Markham, long President of the Royal Geographical Society. Geography, I venture to think, is becoming more and more a description of the earth as it is and as it will be under the working hand of man. It is becoming intensive rather than extensive. Geographers have to record, and will more and more have to record, how far man has changed and is changing the face of the earth, to try and predict how far he will change it in the coming centuries. The face of the earth has been unveiled by man. Will the earth save her face in the years before us, and, if she saves her face, will it be taken at face value? How far, for instance, will lines of latitude and longitude continue to have any practical meaning?

Man includes the ordinary man, the settler, the agriculturalist; man includes, too, the extraordinary—the scientific man, the inventor, the engineer. "Man," says a writer on the subject, "is truly a geographical agency," and I ask you to take account of this agency for a few minutes. I do so more especially because one of the chief features of the present day is the rise of the south; and the rise of the south—notably of Australia—is the direct result of human agency, on the one hand transforming the surface of the land, on the other, eliminating distance. The old name of Australia, as we all know, was New Holland. The name was well chosen in view of later history, for while no two parts of the world could be more unlike one another than the little corner of Europe known as Holland, or the Netherlands, and the great Southern Continent, in the one and in the other man has been preeminently a geographical agency.

The writer who used this phrase, "Man is a geographical agency," the American writer, Mr. G. P. Marsh, published his book, "Man and Nature," in 1864, and a new edition, entitled, "The Earth as Modified by Human Action," in 1874. He was mainly concerned with the destructiveness of man in the geographical and climatic changes which he has effected. "Every

plant, every animal," he writes, "is a geographical agency, man a destructive, vegetables and in some cases even wild beasts, restorative powers"; and again: "It is in general true that the intervention of man has hitherto seemed to ensure the final exhaustion, ruin and desolation of every province of nature which he has reduced to his dominion." The more civilized man has become, he tells us, the more he has destroyed. "Purely untutored humanity interferes comparatively little with the arrangements of nature, and the destructive agency of man becomes more and more energetic and unsparing as he advances in civilization." In short, in his opinion, "better fifty years of Cathay than a cycle of Europe."

He took this gloomy view mainly on account of the mischief done by cutting down forests. Man has wrought this destruction not only with his own hand, but through domesticated animals more destructive than wild beasts, sheep, goats, horned cattle, stunting or killing the young shoots of trees. Writing of Tunisia, Mr. Perkins, the principal of Roseworthy College, says: "In so far as young trees and shrubs are concerned, the passage of a flock of goats will do quite as much damage as a bush fire." Mr. Marsh seems to have met a fool in the forest, and it was man; and he found him to be more knave than fool, for man has been, in Mr. Marsh's view, the revolutionary radical confiscating nature's vested interests. "Man," he says, "has too long forgotten that the earth was given to him for usufruct alone, not for consumption, still less for profligate waste." Trees, to his mind, are conservatives of the best kind. They stand in the way, it is true, but they stop excesses, they moderate the climate, they give shelter against the wind, they store the water, prevent inundations, preserve and enrich the soil. "The clearing of the woods," he says, "has in some cases produced within two or three generations effects as blasting as those generally ascribed to geological convulsions, and has laid waste the face of the earth more hopelessly than if it had been buried by a current of lava or a shower of volcanic sand"; and, once more, where forests have been destroyed, he says, "The face of the earth is no longer a sponge but a dust-heap."

The damage done by cutting down trees, and thereby letting loose torrents which wash away the soil, is or was very marked in the south of France, in Dauphiné, Provence and the French Alps. With the felling of trees and the pasturing of sheep on the upper edge of the forest—for sheep break the soil and expose the roots—the higher ground has been laid bare. Rainstorms have in consequence swept off the soil, and the floods have devastated the valleys. The mountain-sides have become deserts, and the valleys have been turned into swamps. "When they destroyed the forest," wrote the great French geographer, Reclus, about thirty years ago, "they also destroyed the very ground on which it stood"; and then he continues: "The devastating action of the streams in the French Alps is a very curious phenomenon in the historical point of view, for it explains why so many of the districts of Syria, Greece, Asia Minor, Africa, and Spain have been forsaken by their inhabitants. The men have disappeared along with the trees; the axe of the woodman, no less than the sword of the conqueror, have put an end to, or transplanted, entire populations." In the latter part of the South African war Sir William Willcocks, skilled in irrigation in Egypt, and now reclaiming Mesopotamia, was brought to South Africa to report upon the possibilities of irrigation there, and in his report dated

November, 1901, he wrote as follows: "Seeing in Basutoland the effect of about thirty years of cultivation and more or less intense habitation convinced me of the fact that another country with steep slopes and thin depth of soil, like Palestine, has been almost completely denuded by hundreds of years of cultivation and intense habits. The Palestine which Joshua conquered and which the children of Israel inhabited was in all probability covered over great part of its area by sufficient earth to provide food for a population a hundred times as dense as that which can be supported to-day." The Scotch geologist, Hugh Miller, again attributed the formation of the Scotch mosses to the cutting down of timber by Roman soldiers. "What had been an overturned forest became in the course of years a deep morass."

In past times there have been voices raised in favor of the forests, but they have been voices crying in the desert which man has made. Here is one. The old chronicler Holinshed, who, lived in the reign of Queen Elizabeth, noted the amount of timber cut down for house building and in order to increase the area for pasturage. "Every small occasion in my time," he writes, "is enough to cut down a great wood"; and in another passage either he himself or one of his collaborators writes that he would wish to live to see four things reformed in England: "The want of discipline in the Church, the covetous dealing of most of our merchants in the preferment of commodities of other countries and hindrance of their own, the holding of fairs and markets upon the Sunday to be abolished and referred to the Wednesdays, and that every man in whatever part of the champaine soil enjoyeth forty acres of land and upwards after that rate, either by free deed, copyhold or fee farm, might plant one acre of wood or sow the same with oke mast, hazell, beach and sufficient provision be made that it be cherished and kept."

Mr. Marsh seems to have thought that the Old World, and especially the countries which formed the old Roman Empire, had been ruined almost past redemption; and for the beneficent action of man on nature he looked across the seas. "Australia and New Zealand," he writes, "are perhaps the countries from which we have a right to expect the fullest elucidation of these difficult and disputable problems. Here exist greater facilities and stronger motives for the careful study of the topics in question than have ever been found combined in any other theater of European colonization."

His book was first written half a century ago. He was a pessimist evidently, and pessimists exaggerate even more than optimists, for there is nothing more exhilarating and consoling to ourselves than to predict the worst possible consequences from our neighbor's folly. Further, though it may be true that man became more destructive as he became more civilized, it is also true that the destruction has been wrought directly rather by the unscientific than by the scientific man. If we have not grown less destructive since, at any rate we have shown some signs of penitence, and science has come to our aid in the work of reparation. Governments and associations have turned their attention to protecting woodland and reafforesting tracts which have been laid bare. The Touring Club of France, for instance, I am told, has taken up the question of the damage done by destruction of trees by men and sheep in Haute Savoie, and it assists reclamation by guidance and by grants. In England, under the auspices of Birmingham University and under the presidency of Sir Oliver Lodge, the Mid-

lands Reafforestation Association is planting the pit mounds and ash quarries of the Black Country with trees which will resist smoke and bad air, alders, willows, poplars, carrying out their work, a report says, under a combination of difficulties not to be found in any other country. Artificial lakes and reservoirs again, such as I shall refer to presently, are being made woodland centers. In most civilized countries nowadays living creatures are to some extent protected, tree planting is encouraged by arbor days, and reserves are formed for forests, for beasts and birds, the survivors of the wild fauna of the earth. Some lands, such as Greece, as I gather from Mr. Perkins's report, are still being denuded of trees, but as a general rule the human conscience is becoming more and more alive to the immorality and the impolicy of wasting the surface of the earth and what lives upon it, and is even beginning to take stock as to whether the minerals beneath the surface are inexhaustible. Therefore I ask you now to consider man as the lord of creation in the nobler sense of the phrase, as transforming geography, but more as a creative than as a destructive agency.

How far has the agency of man altered, and how far is it likely to alter, the surface of the earth, the divisions and boundaries assigned by nature, the climate and the production of the different parts of the globe; and, further, how far, when not actually transforming nature, is human agency giving nature the go-by? It should be borne in mind that science has effected, and is effecting transformation, partly by applying to old processes far more powerful machinery, partly by introducing new processes altogether; and that, as each new force is brought to light, lands and peoples are to a greater or less extent transformed. The world was laid out afresh by coal and steam. A new readjustment is taking place with the development of water power and oil power. Lands with no coal, but with fine water power or access to oil, are asserting themselves. Oil fuel is prolonging continuous voyages and making coaling stations superfluous. But of necessity it is the earth herself who gives the machinery for altering her own surface. The application of the machinery is contributed by the wit of man.

The surface of the earth consists of land and water. How far has human agency converted water into land or land into water, and how far, without actually transforming land into water and water into land, is it for practical human purposes altering the meaning of land and water as the great geographical divisions? A writer on the Fens of South Lincolnshire has told us: "The Romans, not content with appropriating land all over the world, added to their territory at home by draining lakes and reclaiming marshes." We can instance another great race which, while appropriating land all over the world, has added to it by reclaiming land from water, fresh or salt. The traveler from Great Britain to the most distant of the great British possessions, New Zealand, will find on landing at Wellington a fine street, Lambton Quay, the foreshore of the old beach, seaward of which now rise many of the city's finest buildings on land reclaimed from the sea; and instances of the kind might be indefinitely multipled. Now the amount of land taken from water by man has been taken more from fresh water than from sea, and, taken in all, the amount is infinitesimal as compared with the total area of land and water; but it has been very considerable in certain small areas of the earth's surface, and from these small areas have come races of men who have profoundly modified the geography and history of the world. This may be illus-

trated from the Netherlands and from Great Britain.

Motley, at the beginning of "The Dutch Republic," writes of the Netherlands: "A region, outcast of ocean and earth, wrested at last from both domains their richest treasures." Napoleon was credited with saying that the Netherlands were a deposit of the Rhine, and the rightful property of him who controlled the sources; and an old writer pronounced that Holland was the gift of the ocean and of the rivers Rhine and Meuse, as Egypt is of the river Nile. The crowning vision of Goethe's Faust is that of a free people on a free soil, won from the sea and kept for human habitation by the daily effort of man. Such has been the story of the Netherlands. The Netherlands, as a home for civilized men, were, and are, the result of reclamation, of dykes and polders. The kingdom has a constantly changing area of between 12,000 and 13,000 square miles. Mr. Marsh, in his book, set down the total amount gained to agriculture at the time he wrote "by dyking out the sea and by draining shallow bays and lakes" at some 1,370 square miles, which, he says, was one tenth of the kingdom; at the same time, he estimated that much more had been lost to the sea—something like 2,600 square miles. He writes that there were no important sea dykes before the thirteenth century, and that draining inland lakes did not begin till the fifteenth, when windmills came into use for pumping. In the nineteenth century steam pumps took the place of windmills, science strengthening an already existing process. Between 1815 and 1855, 172 square miles were reclaimed, and this included the Lake of Haarlem, some thirteen miles long by six in breadth, with an area of about seventy-three square miles. This was reclaimed between 1840 and 1853. At the present time, we are told, about forty square miles are being reclaimed annually in Holland; and meanwhile the Dutch government have in contemplation or in hand a great scheme for draining the Zuyder Zee, which amounts to recovering from the ocean land which was taken by it in historic times at the end of the fourteenth century. The scheme is to be carried out in thirty-three years and is to cost nearly sixteen million pounds. The reclamation is to be effected by an embankment across the mouth of this inland sea over eighteen miles long. The result will be to add 815 square miles of land to the kingdom of the Netherlands, 750 square miles of which will be fertile land, and in addition to create a much-needed freshwater lake with an area of 557 square miles; this lake is to be fed by one of the mouths of the Rhine.

London is partly built on marsh. The part of London where I live, Pimlico, was largely built on piles. A little way north, in the center of fashion, is Belgrave Square, and here a lady whom I used to know had heard her grandfather say that he had shot snipe. Take the City of London in the strict and narrow sense. The names of Moorfields and Fensbury or Finsbury are familiar to those who know the city. Stow, in his survey of London, over three hundred years ago, wrote of "The Moorfield which lieth without the postern called Moorgate. This field of old time was called the Moor. This fen or moor field stretching from the wall of the city betwixt Bishopsgate and the postern called Cripplegate to Fensbury and to Holywell continued a waste and unprofitable ground a long time." By 1527, he tells us, it was drained "into the course of Walbrook, and so into the Thames, and by these degrees was this fen or moor at length made main and hard ground which before, being overgrown with flags, sedges and rushes, served to no use." It is said that this fen or marsh had come

into being since Roman times. The reclamation which has been carried out in the case of London is typical of what has been done in numerous other cases. As man has become more civilized, he has come down from his earlier home in the uplands, has drained the valley swamps, and on the firm land thus created has planted the streets and houses of great cities.

The Romans had a hand in the draining of Romney Marsh in Sussex, and here nature cooperated with man, just as she has cooperated in the deltas of the great rivers, for the present state of the old Cinque Ports, Rye and Winchelsea, shows how much on this section of the English coast the sea has receded. But the largest reclamation was in East Anglia, where the names of the Fens and the Isle of Ely testify to what the surface once was. "For some of our fens," writes Holinshed, "are well known to be either of ten, twelve, sixteen, twenty or thirty miles in length. . . . Wherein also Elie, the famous isle, standeth, which is seven miles every way, and whereunto there is no access but by three causies." Arthur Young, in 1799, in his "General View of the Agriculture of the County of Lincoln," a copy of which he dedicated to that great friend of Australia, Sir Joseph Banks, who was a Lincolnshire landowner and a keen supporter of reclamation, wrote of the draining which had been carried out in Lincolnshire. "The quantity of land thus added to the kingdom has been great; fens of water, mud, wild fowl, frogs and agues have been converted to rich pasture and arable worth from 20 s. to 40 s. an acre . . . without going back to very remote periods, there can not have been less than 150,000 acres drained and improved on an average from 5 s. an acre to 25 s." 150,000 acres is about 234 square miles, but the amount reclaimed by draining in Lincolnshire in the seventeenth, eighteenth and nineteenth centuries seems to have been well over 500 square miles. The Fenlands, as a whole, extended into six counties. They were seventy miles in length, from ten to thirty miles broad, and covered an area of from 800 to 1,000 square miles. One estimate I have seen is as high as 1,200 square miles. Mr. Prothero, in his book on "English Farming, Past and Present," tells us that they were "in the seventeenth century a wilderness of bogs, pools and reed shoals—a vast morass from which here and there emerged a few islands of solid earth." In the seventeenth century a Dutch engineer, Vermuyden, was called in to advise, and the result of draining what was called after the peer who contracted for it the Bedford Level, together with subsequent reclamations, was to convert into ploughland and pasture large tracts which, in the words of an old writer, Dugdale, had been "a vast and deep fen, affording little benefit to the realm other than fish or fowl, with overmuch harbor to a rude and almost barbarous sort of lazy and beggarly people." In Lincolnshire there was a district called Holland, and in Norfolk one called Marshland, said to have been drained by, to quote Dugdale again, "those active and industrious people, the Romans."

The Dutch and the English, who thus added to their home lands by reclamation, went far and wide through the world, changing its face as they went. The Dutch, where they planted themselves, planted trees also; and when they came to land like their own Netherlands, again they reclaimed and empoldered. The foreshore of British Guiana, with its canals and sea defences, dating from Dutch times, is now the chief sugar-producing area in the British West Indies. If again in Australia man has been a geographical agency, he

learnt his trade when he was changing the face of his old home in the British Isles.

Instances of reclaiming land from water might be indefinitely multiplied. We might compare the work done by different nations. In Norway, for instance, Reclus wrote that "the agriculturists are now reclaiming every year forty square miles of the marshes and fiords." Miss Semple, who, in the "Influences of Geographic Environment," writes that "between the Elbe and Scheldt" (that is, including with the Netherlands some of North Germany) "more than 2,000 square miles have been reclaimed from river and sea in the past 300 years," tells us also that "the most gigantic dyke system in the world is that of the Hoangho, by which a territory of the size of England is won from the water for cultivation." Or we might take the different objects which have impelled men here and there to dry up water and bank out sea. Agriculture has not been the only object, nor yet reclaiming for town sites. Thus, in order to work the hematite iron mines at Hodbarrow, in Cumberland, an area of 170 acres was, in the years 1900–1904, reclaimed from the sea by a barrier over 1¼ miles long, designed by the great firm of marine engineers, Coode and Matthews, who built the Colombo breakwater. The reclaimed land, owing to the subsidence caused by the workings, is now much below the level of the sea. Here is an instance of reclamation not adding to agricultural or pastoral area, but giving mineral wealth, thereby attracting population and enriching a district.

How far has land been drowned by the agency of man? Again the total area is a negligible quantity, but again, relatively to small areas, it has been appreciable, and the indirect effects have been great. The necessities of town life are responsible for new lakes and rivers. Such are the great reservoirs and aqueducts by which water is being brought to New York from the Catskill Mountains, a work which the writer in the *Times* has described as "hardly second in magnitude and importance to the Panama Canal." In Great Britain cities in search of water supply have ordered houses, churches, fields to be drowned, and small lakes to come into existence. Liverpool created Lake Vyrnwy in Montgomeryshire, with a length of nearly five miles and an area of 1,121 acres. Birmingham is the parent of a similar lake in a wild Radnorshire valley near my old home. The water is not carried for anything like the distance from Mundaring to Kalgoorlie, and on a much greater scale than these little lakes in Wales is the reservoir now being formed in New South Wales by the Burrinjuck dam, on the Murrumbidgee River, which, as I read, is, or will be, forty-one miles long, and cover an area of twenty square miles. If I understand right, in this case, by holding up the waters of a river, a long narrow lake has been or is being called into existence. A still larger volume of water is gathered by the great Assouan dam, which holds up the Nile at the head of the First Cataract, washing, and at times submerging, the old temples on the Island of Philæ in midstream. First completed in 1902, the dam was enlarged and heightened by 1912; and the result of the dam is at the time of high Nile to create a lake of some 65 square miles in area, as well as to fill up the channel of the river for many miles up stream. Illustrations of artificial lakes might be multiplied from irrigation works in India. An official report on the state of Hyderabad, written some years ago, has the following reference to the tanks in the granitic country of that state: "There are no natural lakes, but from the earliest times advantage has been taken of the undulating character of the country to

dam up some low ground or gorge between two hills, above which the drainage of a large area is collected. Such artificial reservoirs are peculiar to the granitic country, and wherever groups of granite hills occur tanks are sure to be found associated with them." Take again the great ship canals. The Suez Canal runs for 100 miles from sea to sea, though for part of its course it runs through water, not through sand. It is constantly growing in depth and width. Its original depth was 26¼ feet; it is now, for nine tenths of its length, over 36 feet, and the canal is to be further deepened generally to over 39 feet. Its original width at the bottom was 72 feet; it is now, for most of its course, over 147 feet; in other words, the width has been more than doubled. A writer in the *Times* on the wonderful Panama Canal said: "The locks and the Gatun dam have entailed a far larger displacement of the earth's surface than has ever been attempted by the hand of man in so limited a space." Outside the locks the depth is 45 feet, and the minimum bottom width 300 feet. The official handbook of the Panama Canal says: "It is a lake canal as well as a lock canal, its dominating feature being Gatun Lake, a great body of water covering about 164 square miles." The canal is only fifty miles long from open sea to open sea, from shore line to shore line only forty. But in making it man, the geographical agency, has blocked the waters of a river, the Chagres, by building up a ridge which connects the two lines of hills between which the river flows, this ridge being a dam 1½ miles long, nearly half a mile wide at its base, and rising to 105 feet above sea-level, with the result that a lake has come into existence which is three quarters of the size of the Lake of Geneva, and extends beyond the limits of the Canal zone.

Mr. Marsh, in his book, referred to far more colossal schemes for turning land into water, such as flooding the African Sahara or cutting a canal from the Mediterranean to the Jordan and this submerging the basin of the Dead Sea, which is below the level of the ocean. The effect of the latter scheme, he estimated, would be to add from 2,000 to 3,000 square miles to the fluid surface of Syria. All that can be said is that the wildcat schemes of one century often become the domesticated possibilities of the next and the accomplished facts of the third; that the more discovery of new lands passes out of sight the more men's energies and imagination will be concentrated upon developing and altering what is in their keeping; and that, judging from the past, no unscientific man can safely set any limit whatever to the future achievements of science.

But now, given that the proportion of land to water and water to land has not been, and assuming that it will not be, appreciably altered, has water, for practical purposes, encroached on land, or land on water? In many cases water transport has encroached on land transport. The great isthmus canals are an obvious instance; so are the great Canadian canals. The tonnage passing through the locks of the Sault St. Marie is greater than that which is carried through the Suez Canal. Waterways are made where there was dry land, and more often existing inland waterways are converted into sea-going ways. Manchester has become a seaport through its ship canal. The Clyde, in Mr. Vernon Harcourt's words, written in 1895, has been "converted from an insignificant stream into a deep navigable river capable of giving access to ocean-going vessels of large draught up to Glasgow." In 1758 the Clyde at low water at Glasgow was only 15 inches deep, and till 1818 no seagoing vessels came up to Glasgow. In 1895 the

depth at low water was from 17 to 20 feet, and steamers with a maximum draught of 25½ feet could go up to Glasgow. This was the result of dredging, deepening and widening the river, and increasing the tidal flow. The record of the Tyne has been similar. The effect of dredging the Tyne was that in 1895—I quote Mr. Harcourt again —"Between Shields and Newcastle, where formerly steamers of only 3 to 4 feet draught used to ground for hours, there is now a depth of 20 feet throughout at the lowest tides." It is because engineers have artificially improved nature's work on the Clyde and the Tyne that these rivers have become homes of shipbuilding for the whole world. Building training walls on the Seine placed Rouen, seventy-eight miles up the river, high among the seaports of France. The Elbe and the Rhine, the giant rivers Mississippi and St. Lawrence, and many other rivers, have, as we all know, been wonderfully transformed by the hand of the engineer.

But land in turn, in this matter of transport, has encroached upon sea. In old days, when roads were few and bad, when there were no railways, and when ships were small, it was all-important to bring goods by water at all parts as far inland as possible. In England there were numerous flourishing little ports in all the estuaries and up the rivers, which, under modern conditions, have decayed. No one now thinks of Canterbury and Winchester in connection with seaborne traffic; but Mr. Belloc, in "The Old Road," a description of the historical Pilgrims' Way from Winchester to Canterbury, points out how these two old-world cathedral cities took their origin and derived their importance from the fact that each of them, Canterbury in particular, was within easy reach of the coast, where a crossing from France would be made; each on a river—in the case of Canterbury on the Stour just above the end of the tideway. In the days when the Island of Thanet was really an island, separated from the rest of Kent by an arm of the sea, and when the present insignificant river Stour was, in the words of the historian J. R. Green, "a wide and navigable estuary," Canterbury was a focus to which the merchandise of six Kentish seaports was brought, to pass on inland; it was in effect practically a seaport. Now merchandise, except purely local traffic, comes to a few large ports only, and is carried direct by rail to great distant inland centers. Reclus wrote that bays are constantly losing in comparative importance as the inland ways of rapid communication increase; that, in all countries intersected with railways, indentations in the coastline have become rather an obstacle than an advantage; and that maritime commerce tends more and more to take for its starting-place ports situated at the end of a peninsula. He argues, in short, that traffic goes on land as far out to sea as possible instead of being brought by water as far inland as possible. He clearly overstated the case, but my contention is that, for human purposes, the coast-line, though the same on the map, has practically been altered by human agency. Ports have been brought to men as much as men to ports. We see before our eyes the process going on of bridging India to Ceylon so as to carry goods and passengers as far by land as possible, and in Ceylon we see the great natural harbor of Trincomalee practically deserted and a wonderful artificial harbor created at the center of population, Colombo.

But let us carry the argument a little further. Great Britain is an island. Unless there is some great convulsion of nature, to all time the Strait of Dover will separate it from the continent of Europe.

Yet we have at this moment a renewal of the scheme for a Channel tunnel, and at this moment men are flying from England to France and France to England. Suppose the Channel tunnel to be made; suppose flying to be improved—and it is improving every day—what will become of the island? What will become of the sea? They will be there and will be shown on the map, but to all human intents and purposes the geography will be changed. The sea will no longer be a barrier, it will no longer be the only high-road from England to France. There will be going to and fro on or in dry land, and going to and fro neither on land nor on sea. Suppose this science of aviation to make great strides, and heavy loads to be carried in the air, what will become of the ports, and what will become of sea-going peoples? The ports will be there, appearing as now on the map, but Birmingham goods will be shipped at Birmingham for foreign parts, and Lithgow will export mineral direct, saying good-bye to the Blue Mountains and even to Sydney harbor.

Now, in saying this I may well be told by my scientific colleagues that it is all very well as a pretty piece of fooling, but that it is not business. I say it as an unscientific man with a profound belief in the limitless possibilities of science. How long is it since it was an axiom that, as a lump of iron sinks in water, a ship made of iron could not possibly float? Is it fatuous to contemplate that the conquest of the air, which is now beginning, will make it a highway for commercial purposes? We have aeroplanes already which settle on the water and rise again; we are following on the track of the gulls which we wonder at far away in the limitless waste of ocean. A century and a half ago the great Edmund Burke ridiculed the idea of representatives of the old North American colonies sitting in the Imperial Parliament; he spoke of any such scheme as fighting with nature and conquering the order of Providence; he took the distance, the time which would be involved—six weeks from the present United States to London. If any one had told him that what is happening now through the applied forces of science might happen, he would have called him a madman. Men think in years, or at most in lifetimes; they ought sometimes to think in centuries. I believe in Reclus's words, "All man has hitherto done is a trifle in comparison with what he will be able to effect in future." Science is like a woman. She says no again and again, but means yes in the end.

In dealing with land and water I have touched upon natural divisions and natural boundaries, which are one of the provinces of geography. Flying gives the go-by to all natural divisions and boundaries, even the sea; but let us come down to the earth. Isthmuses are natural divisions between seas; the ship canals cut them and link the seas—the canal through the Isthmus of Corinth, the canal which cuts the Isthmus of Perekop between the Crimea and the mainland of Russia, the Baltic Canal, the Suez Canal, the Panama Canal. The Suez Canal, it will be noted, though not such a wonderful feat as the Panama Canal, is more important from a geographical point of view, in that an open cut has been made from sea to sea without necessity for locks, which surmount the land barrier but more or less leave it standing. Inland, what are natural divisions? Mountains, forests, deserts, and, to some extent, rivers. Take mountains. "High, massive mountain systems," writes Miss Semple, "present the most effective barriers which man meets on the land surface of the earth." But are the Rocky Mountains, for instance, boundaries, dividing lines, to anything like the extent that they were now that railways go through and

over them, carrying hundreds of human beings back and fore day by day? On what terms did British Columbia join the Dominion of Canada? That the natural barrier between them should be pierced by the railway. Take the Alps. The canton Ticino, running down to Lake Maggiore, is politically in Switzerland; it is wholly on the southern side of the Alps. Is not the position entirely changed by the St. Gothard tunnel, running from Swiss territory into Swiss territory on either side of the mountains?

If, in the Bible language, it requires faith to remove mountains, it is not wholly so with other natural boundaries. Forests were, in old days, very real natural dividing lines. They were so in England, as in our own day they have been in Central Africa. Between forty and fifty years ago, in his "Historical Maps of England," Professor C. H. Pearson, whose name is well known and honored in Australia, laid down that England was settled from east and west, because over against Gaul were heavy woods, greater barriers than the sea. Kent was cut off from Central England by the Andred Weald, said to have been, in King Alfred's time, 120 miles long and 30 broad. Here are Professor Pearson's words: "The axe of the woodman clearing away the forests, the labor of nameless generations reclaiming the fringes of the fens or making their islands habitable, have gradually transformed England into one country, inhabited by one people. But the early influences of the woods and fens are to isolate and divide." Thus the cutting down of trees is sometimes a good, not an evil, and there are some natural boundaries which man can wholly obliterate.

Can the same be said of deserts? They can certainly be pierced, like isthmuses and like mountains. The Australian desert is a natural division between western and south Australia. The desert will be there, at any rate for many a long day after the transcontinental railway has been finished, but will it be, in anything like the same sense as before, a barrier placed by nature and respected by man? Nor do railways end with simply giving continuous communication, except when they are in tunnels. As we all know, if population is available, they bring in their train development of the land through which they pass. Are these deserts of the earth always going to remain "deserts idle"? Is man going to obliterate them? In the days to come, will the desert rejoice and blossom as the rose? What will dry farming and what will afforestation have to say? In the evidence taken in Australia by the Dominions Royal Commission, the Commissioner for Irrigation in New South Wales tells us that "the dry farming areas are carried out westward into what are regarded as arid lands every year," and that, in his opinion, "we are merely on the fringe of dry farming" in Australia. A book has lately been published entitled "The Conquest of the Desert." The writer, Dr. Macdonald, deals with the Kalahari Desert in South Africa, which he knows well, and for the conquest of the desert he lays down that three things are essential—population, conservation and afforestation. He points out in words which might have been embodied in Mr. Marsh's book, how the desert zone has advanced through the reckless cutting of trees, and how it can be flung back again by tree barriers to the sand dunes. By conservation he means the system of dry farming so successful in the United States of America, which preserves the moisture in the soil and makes the desert produce fine crops of durum wheat without a drop of rain falling upon it from seedtime to harvest, and he addresses his book "to the million settlers of to-morrow upon the dry and desert lands

of South Africa." If the settlers come, he holds that the agency of man, tree-planting, ploughing and harrowing the soil, will drive back and kill out the desert. The effect of tree-planting in arresting the sand dunes and reclaiming desert has been very marked in the Landes of Gascony. Here, I gather from Mr. Perkins's report, are some 3,600 square miles of sandy waste, more than half of which had, as far back as 1882, been converted into forest land, planted mainly with maritime pines.

What, again, will irrigation have to say to the deserts? Irrigation, whether from underground or from overground waters, has already changed the face of the earth, and as the years go on, as knowledge grows and wisdom, must inevitably change it more and more. I read of underground waters in the Kalahari. I read of them too in the Libyan Desert. In the *Geographical Journal* for 1902 it is stated that at that date nearly 22,000 square miles in the Algerian Sahara had been reclaimed with water from artesian wells. What artesian and sub-artesian water has done for Australia you all know. If it is not so much available for agricultural purposes, it has enabled flocks and herds to live and thrive in what would be otherwise arid areas. Professor Gregory, Mr. Gibbons Cox, and others have written on this subject with expert knowledge; evidence has been collected and published by the Dominions Royal Commission, but I must leave to more learned and more controversial men than I am to discuss whether the supplies are plutonic or meteoric, and how far in this matter you are living on your capital.

If we turn to irrigation from overground waters, I hesitate to take illustrations from Australia, because my theme is the blotting out of the desert, and most of the Australian lands which are being irrigated from rivers, and made scenes of closer settlement, would be libeled if classed as desert. Mr. Elwood Mead told the Royal Commission that the state irrigation works in Victoria, already completed or in process of construction, can irrigate over 600 square miles, and that, if the whole water supply of the state were utilized, more like 6,000 square miles might be irrigated. The Burrinjuck scheme in New South Wales will irrigate, in the first instance, not far short of 500 square miles, but may eventually be made available for six times that area. If we turn to irrigation works in India, it appears from the second edition of Mr. Buckley's work on the subject, published in 1905, that one canal system alone, that of the Chenab in the Punjab, had, to quote his words, turned "some two million acres of wilderness (over 3,000 square miles) into sheets of luxuriant crops." "Before the construction of the canal," he writes, "it was almost entirely waste, with an extremely small population, which was mostly nomad. Some portion of the country was wooded with jungle trees, some was covered with small scrub camel thorn, and large tracts were absolutely bare, producing only on occasions a brilliant mirage of unbounded sheets of fictitious water." The Chenab irrigation works have provided for more than a million of human beings; and, taking the whole of India, the Irrigation Commission of 1901–03 estimated that the amount of irrigated land at that date was 68,750 square miles; in other words, a considerably larger area than England and Wales. Sir William Willcocks is now reclaiming the delta of the Euphrates and Tigris. The area is given as nearly 19,000 square miles, and it is described as about two thirds desert and one third freshwater swamp. Over 4,000 square miles of the Gezireh Plain, between the Blue and the White Nile, are about to be reclaimed, mainly for cotton cultivation,

by constructing a dam on the Blue Nile at Sennaar and cutting a canal 100 miles long which, if I understand right, will join the White Nile thirty miles south of Khartoum.

With the advance of science, with the growing pressure of population on the surface of the earth, forcing on reclamation as a necessity for life, is it too much to contemplate that human agency in the coming time will largely obliterate the deserts which now appear on our maps? It is for the young peoples of the British Empire to take a lead in—to quote a phrase from Lord Durham's great report—"the war with the wilderness," and the great feat of carrying water for 350 miles to Kalgoorlie, in the very heart of the wilderness, shows that Australians are second to none in the ranks of this war.

It is a commonplace that rivers do not make good boundaries because they are easy to cross by boat or bridge. Pascal says of them that they are "des chemins qui marchent" (roads that move), and we have seen how these roads have been and are being improved by man. "Rivers unite," says Miss Semple; and again, "Rivers may serve as political lines of demarcation, and therefore fix political frontiers, but they can never take the place of natural boundaries. All the same, in old times, at any rate, rivers were very appreciable dividing lines, and when you get back to something like barbarism, that is to say in time of war, it is realized how powerful a barrier is a river. Taking, then, rivers as in some sort natural boundaries, or treating them only as political boundaries, the point which I wish to emphasize is that they are becoming boundaries which, with modern scientific appliances, may be shifted at the will of man. In the days to come the diversion of rivers may become the diversion of a new race of despotic rulers with infinitely greater power to carry out their will or their whim than the Pharaohs possessed when they built the Pyramids. You in Australia know how thorny a question is that of the control of the Murray and its tributaries. There are waterways conventions between Canada and the United States. Security for the headwaters of the Nile was, and is, a prime necessity for the Sudan and Egypt. The Euphrates is being turned from one channel into another. What infinite possibilities of political and geographical complications does man's growing control over the flow of rivers present!

Thus I have given you four kinds of barriers or divisions set by nature upon the face of the earth—mountains, forests, deserts, rivers. The first, the mountains, man can not remove, but he can and he does go through them to save the trouble and difficulty of going over them. The second, the forests, he has largely cleared away altogether. The third, the deserts, he is beginning to treat like the forests. The fourth, the rivers, he is beginning to shift when it suits his purpose and to regulate their flow at will.

I turn to climate. Climates are hot or cold, wet or dry, healthy or unhealthy. Here our old friends the trees have much to say. Climates beyond dispute become at once hotter and colder when trees have been cut down and the face of the earth has been laid bare; they become dryer or moister according as trees are destroyed or trees are planted and hold the moisture; the cutting and planting of timber affects either one way or the other the health of a district. The tilling of the soil modifies the climate. This has been the case, according to general opinion, in the northwest of Canada, though I have not been able to secure any official statistics on the subject. In winter time broken or ploughed land does not hold the snow and ice to the same

extent as the unbroken surface of the prairie; on the other hand, it is more retentive at once of moisture and of the rays of the sun. The result is that the wheat zone has moved further north, and that the intervention of man has, at any rate for agricultural purposes, made the climate of the great Canadian northwest perceptibly more favorable than it was. In Lord Strathcona's view, there was some change even before the settlers came in, as soon as the rails and telegraph lines of the Canadian Pacific Railway were laid. He told me that in carrying the line across a desert belt it was found that, within measurable distance of the rail and the telegraph line, there was a distinct increase of dew and moisture. I must leave it to men of science to say whether this was the result of some electrical or other force, or whether what was observed was due simply to a wet cycle coinciding with the laying of the rails and the erection of the wires. I am told that it is probably a coincidence of this kind, which accounts for the fact that in the neighborhood of the Assouan dam there is at present a small annual rainfall, whereas in past years the locality was rainless. Reference has already been made to the effect of cultivation in the Kalahari Desert in increasing the storage of moisture in the soil. But it is when we come to the division between healthy and unhealthy climates that the effect of science upon climate is most clearly seen. The great researches of Ross, Manson and many other men of science, British and foreign alike, who have traced malaria and yellow fever back to the mosquito, and assured the prevention and gradual extirpation of tropical diseases, bid fair to revolutionize climatic control. Note, however, that in our penitent desire to preserve the wild fauna of the earth we are also establishing preserves for mosquitoes, trypanosomes and the tsetse fly.

Nowhere have the triumphs of medical science been more conspicuous than where engineers have performed their greatest feats. De Lesseps decided that Ismailia should be the headquarters of the Suez Canal, but the prevalence of malaria made it necessary to transfer the headquarters to Port Said. In 1886 there were 2,300 cases of malaria at Ismailia; in 1900 almost exactly the same number. In 1901 Sir Ronald Ross was called in to advise; in 1906 there were no fresh cases, and the malaria has been stamped out. De Lessep's attempt to construct the Panama Canal was defeated largely, if not mainly, by the frightful death-rate among the laborers; 50,000 lives are said to have been lost, the result of malaria and yellow fever. When the Americans took up the enterprise they started with sending in doctors and sanitary experts, and the result of splendid medical skill and sanitary administration was that malaria and yellow fever were practically killed out. The Panama Canal is a glorious creation of medical as well as of engineering science, and this change of climate has been mainly due to reclamation of pools and swamps, and to cutting down bush, for even the virtuous trees, under some conditions, conduce to malaria. Man is a geographical agency, and in no respect more than in the effect of his handiwork on climate, for climate determines products, human and others. Science is deciding that animal pests shall be extirpated in the tropics, and that there shall be no climates which shall be barred to white men on the ground of danger of infection from tropical diseases.

If we turn to products, it is almost superfluous to give illustrations of the changes wrought by man. As the incoming white man has in many places supplanted the colored aboriginal, so the plants and the living creatures brought in by the white man have in many cases, as you know well,

ousted the flora and fauna of the soil. Here is one well-known illustration of the immigration of plants. Charles Darwin, on the voyage of the *Beagle,* visited the island of St. Helena in the year 1836. He wrote "that the number of plants now found on the island is 746, and that out of these fifty-two alone are indigenous species." The immigrants, he said, had been imported mainly from England, but some from Australia, and, he continued, "the many imported species must have destroyed some of the native kinds, and it is only on the highest and steepest ridges that the indigenous flora is now predominant."

Set yourselves to write a geography of Australia as Australia was when first made known to Europe, and compare it with a geography now. Suppose Australia to have been fully discovered when Europeans first reached it, but consider the surface then and the surface now, and the living things upon the surface then and now. Will not man have been found to be a geographical agency? How much waste land, how many fringes of desert have been reclaimed? The wilderness has become pasture land, and pasture land, in turn, is being converted into arable. The Blue Mountains, which barred the way to the interior, are now a health resort. Let us see what Sir Joseph Banks wrote after his visit to Australia on Captain Cook's first voyage in 1770. He has a chapter headed "Some Account of that part of New Holland now called New South Wales." New Holland he thought "in every respect the most barren country I have seen"; "the fertile soil bears no kind of proportion to that which seems by nature doomed to everlasting barrenness." "In the whole length of coast which we sailed along there was a very unusual sameness to be observed in the face of the country. Barren it may justly be called, and in a very high degree, so far, at least, as we saw." It is true that he only saw the land by the sea, but it was the richer eastern side of Australia, the outer edge of New South Wales and Queensland. What animals did he find in Australia? He "saw an animal as large as a greyhound, of a mouse color, and very swift." "He was not only like a greyhound in size and running, but had a tail as long as any greyhound's. What to liken him to I could not tell." Banks had a greyhound with him, which chased this animal. "We observed, much to our surprise, that, instead of going upon all fours, this animal went only on two legs, making vast bounds." He found out that the natives called it kangooroo, and it was "as large as a middling lamb." He found "this immense tract of land," which he said was considerably larger than all Europe, "thinly inhabited, even to admiration, at least that part of it that we saw." He noted the Indians, as he called them, whom he thought "a very pusillanimous people." They "seemed to have no idea of traffic"; they had "a wooden weapon made like a short scimitar." Suppose a new Sir Joseph Banks came down from the planet Mars to visit Australia at this moment, what account would he give of it in a geographical handbook for the children of Mars? He would modify the views about barrenness, if he saw the cornfields and flocks and herds; if he visited Adelaide, he would change his opinion as to scanty population, though not so, perhaps, if he went to the back blocks. He would record that the population was almost entirely white, apparently akin to a certain race in the North Sea, from which, by tradition, they had come; that their worst enemies could not call them pusillanimous; that they had some ideas of traffic, and used other weapons than a wooden scimitar; and he would probably give the

first place in animal life not to the animal like a greyhound on two legs; but to the middling lamb, or perhaps to the ubiquitous rabbit. Australia is the same island continent that it always was; there are the same indentations of coast, the same mountains and rivers, but the face of the land is different. In past years there was no town, and the country was wilderness; on the surface of the wilderness many of the living things were different; and from under the earth has come water and mineral, the existence of which was not suspected. A century hence it will be different again, and I want to see sets of maps illustrating more clearly than is now the case the changes which successive generations of men have made and are making in the face of Australia and of the whole earth.

More than half a century ago Buckle, in his "History of Civilization," wrote: "Formerly the richest countries were those in which nature was most bountiful; now the richest countries are those in which man is most active. For in our age of the world, if nature is parsimonious we know how to compensate her deficiencies. If a river is difficult to navigate, or a country difficult to traverse, an engineer can correct the error and remedy the evil. If we have no rivers we make canals; if we have no natural harbors we make artificial ones." These words have a double force at the present day and in the present surroundings, for nowhere has man been more active as a geographical agency than in Australia; and not inside Australia only, but also in regard to the relations of Australia to the outside world.

An island continent Australia is still, and always will be, on the maps. It always will be the same number of miles distant from other lands; but will these maps represent practical everyday facts? What do miles mean when it takes a perpetually diminishing time to cover them? Is it not truer to facts to measure distances, as do Swiss guides, in Stunden (hours)? What, once more, will an island continent mean if the sea is to be overlooked and overflown? The tendency is for the world to become one; and we know perfectly well that, as far as distance is concerned, for practical purposes the geographical position of Australia has changed through the agency of scientific man. If you come to think of it, what geography has been more concerned with than anything else, directly or indirectly, is distance. It is the knowledge of other places not at our actual door that we teach in geography, how to get there, what to find when we get there, and so forth. The greatest revolution that is being worked in human life is the elimination of distance, and this elimination is going on apace. It is entering into every phase of public and private life, and is changing it more and more. The most difficult and dangerous of all Imperial problems at this moment is the color problem, and this has been entirely created by human agency, scientific agency, bringing the lands of the colored and the white men closer together. Year after year, because distance is being diminished, coming and going of men and of products is multiplying; steadily and surely the world is becoming one continent. This is what I want geographers to note and the peoples to learn. Geographers have recorded what the world is according to nature. I want them to note and teach others to note how under an all-wise Providence it is being subdued, replenished, recast and contracted by man.

CHARLES P. LUCAS

PROFESSOR HUGO KRONECKER

HUGO KRONECKER, for the last thirty years professor of physiology at the University of Berne, Switzerland, died June 6. Although

seventy-five years old, death surprised him in the midst of scientific activity. He attended the last meeting of the German Congress of Physiologists at Berlin where, on the fifth of June, he demonstrated experiments which should support the neurogenic theory of the origin of the heart beat. On his way home he stopped at Nauheim, to inspect an apparatus which he installed there for the study and use in cardiac diseases. His death came there, suddenly, like a flash—perhaps by means of the cardiac center which he discovered thirty years before.

Kronecker was one of the last of a classical period in German physiology. He was pupil, assistant and intimate friend of the master minds of that period: Helmholtz, du Bois-Reymond and Carl Ludwig. At the same time, he was master and friend of many leading physiologists of a later generation and of many countries; he was an international leader in his science.

He was born in Liegnitz, Prussia, from a well-to-do family with scientific proclivities. The celebrated mathematician Leopold Kronecker was his older brother. After finishing his general education at the Gymnasium in Liegnitz he studied medicine in Berlin, Heidelberg and Pisa (Italy). In Heidelberg he came under the special influence of Helmholtz, who introduced Kronecker into the science of physiology. The problem of muscular fatigue which Kronecker studied first under Helmholtz and which he treated in his thesis became the source of many important investigations which he carried out at various times during his scientific career. In 1865 he became assistant to Traube. This celebrated clinician was the first man to employ experimental physiology for the study of medical problems. It was probably due to the early influence of Traube that Kronecker acquired the inclination to make results, obtained in physiological studies, available for clinical medicine. On account of a temporary pulmonary affection, Traube sent him to Italy where he stayed for some time, an incident which left a mark upon Kronecker's future activities. The acquisition of the knowledge and the use of the Italian language was unquestionably a factor in his future intimate relations with the Italian physiologists. He recovered his health and even served in the Prussian wars with Austria and France. In the Franco-Prussian war he received the iron cross for bravery. In 1868 he entered Ludwig's celebrated "Physiologische Anstalt zu Leipzig," where he remained until 1876, becoming assistant in 1871, and professor extraordinarus in 1874. In 1877 he was called to Berlin to become the head of the division of experimental physiology in the Institute of Physiology which had been recently organized by du Bois-Reymond. In 1884 he was called to Berne, where he filled the chair of physiology until the last day of his life.

Kronecker's scientific activities extended over more than half a century; his thesis appeared 1863. But the investigation which raised him to the rank of a first-class physiologist was his work on "fatigue and recovery of striated muscles" published from Ludwig's laboratory in 1872. The careful planning of the experiments, the exactness and skill with which they were executed and the sharp analysis which permitted the derivation of general laws put a classical stamp upon this piece of work; its celebrated tracings were the starting point for many future ergographic studies. The later work during his Leipzig period was mainly devoted to the cardiac muscle; some of the results found a permanent place in physiology. I may mention here the development of the "all or none" law; the loss of irritability of the cardiac muscle during systole (refractory period, Marey); the importance of inorganic salts for the heart beat (with Merunowitz and others). Of his many investigations during his Berlin period I should mention the studies which led up to the use of transfusion as a life-saving means (present-day writers do not seem to know that Kronecker was the inventor of this method); the extensive studies (with his colaborers) on the physiology of deglutition; the discovery of a coordinating center in the heart. I wish to record here the fact that Kronecker had an essential share in the development of the clinically important methods of studying blood pressure in human beings. The

first human sphygmomanometric studies are usually ascribed to Von Basch; but Von Basch carried out these studies in Kronecker's laboratory and under his direction and assistance. I can testify to that as an eye-witness.

During his long stay in Berne a great many physiological subjects were investigated in conjunction with advanced coworkers or students. The results were usually published under the name of the coworkers. In the last years of his life he was intensely interested in experiments which could throw light upon the origin of the heart beat; he was a firm believer in the neurogenic theory.

A subject in which he took a great interest in the last two decades of his life was the nature and origin of mountain disease. The Swiss government, before granting permission to build the now famous Jungfrau railroad, asked Kronecker to pass an opinion, whether going up a high mountain in a railway would be accompanied by mountain disease and other disturbances of health. This gave rise to numerous studies connected with this question. Kronecker organized a party of sixty, who ascended the Zermat Breithorn; some of the party were carried up, in order to eliminate muscular action. Circulation, respiration and other functions were then investigated. The problem was also studied in pneumatic chambers with lowered atmospheric pressure. Kronecker came to the conclusion that the syndrome of mountain disease was primarily due to mechanical causes, to a stasis in the intrapulmonary veins, brought about by rarification of the air in higher altitudes. Kronecker's publications gave rise to many international studies which caused the Italian physiologist Mosso, with the aid of Kronecker, to establish an international institute on Monte Rosa for the study of physiological phenomena in the mountains.

Kronecker was a master in physiological methods; he invented many instruments which found a permanent place in the methods of experimental physiology, of which I shall mention here only his well-known induction coil, divided in units, the "perfusion canula" and the frog heart manometer. The perfusion canula (or its modification) has been and still is extensively used in pharmacological studies upon the frog's heart.

In the seventies, during Kronecker's stay at Leipzig, Ludwig's physiological institute was an international center for physiology and physiologists. Many English, Italian, American, Russian, Belgian, Scandinavian and French physiologists received there their training in physiology. Kronecker, who spoke many languages fluently, has been of great assistance to them. With his very kind, unselfish nature he was always ready to help them with his rare experimental skill and in every other direction. Many who worked there during that period bear witness that Kronecker was the "soul" of the laboratory. Here he formed strong bonds of a lifelong friendship with men who became later international leaders in science. I need only mention here Bowditch and Minot of the United States; Lauder Brunton, Gaskell and Schäfer of England; Alberto Mosso and Luciani of Italy; Paul Heger of Belgium and Holmgren of Sweden. Very few men had the happiness of having so many true friends as Kronecker, and few could be a truer friend than he. He had the esteem and affection of all who had the good fortune to know him well.

His international, cordial relations to so many physiologists of so many countries was not a small factor in the success of the International Congress of Physiologists, which was founded by Michael Foster and Kronecker. In his obituary of Sir Michael Foster, Gaskell states that "when the International Medical Congress met in London in 1881 he (Foster) and Kroneceker together drew up a scheme for a separate International Congress of Physiology to meet every three years and a committee was formed." According to Heger the final decision, to call that Congress into being, was made by a group of physiologists who met September, 1888, in Kronecker's house in Berne. The third International Congress met in Berne under Kronecker's presidency.

Kronecker was also the chief founder and for some time the president of the Institut Marey in Paris, an international institution

for the study of physiology by the newest and most approved methods.

The Hallerianum, Kronecker's magnificent physiological laboratory in Berne, has been for years an international center for physiological investigators. English, American, Italian and Russian students went there to learn methods and to be initiated in physiological research. Well-known physiologists often worked in this laboratory, for instance Cyon, Gamgey, Heger and others. At his attractive home, presided over gracefully by Mrs. Kronecker, a cultured lady and an accomplished linguist, one often met celebrated scientists from all over the world. Kühne, Mosso, Bowditch, Schäfer and Foster were often there.

Kronecker was a foreign member of our National Academy of Sciences, of the Royal Society and of many European Academies. He had conferred upon him honorary degrees from a great many universities. In England alone he received the degree of LL.D. from the universities of Glasgow, Aberdeen, St. Andrews and Edinburgh, and the degree of D.Sc. from Cambridge.

He had pupils all over the world. Of American investigators who worked under Kronecker at one time or another I shall mention only the following: Mills, Stanley Hall, Cushing, Gies, H. C. Jackson, H. C. Wood, Jr., Cutter, Carter, Busch, Mühlberg, Mays, McGuire, Arnold and Meltzer.

Before concluding I wish to call attention to the following few incidents which bear witness to the nobility of Kronecker's character. The phenomenon of the "refractory period" which is generally ascribed to Marey, was observed and clearly described by Kronecker one year before Marey. Kronecker never made any effort for the recognition of his priority, and both physiologists remained intimate friends during their entire life. I have mentioned above that Kronecker had a share, at least equal to that of Von Basch, in being one of the first who introduced the era of studying blood pressure in human beings. But when Von Basch and others neglected to give him credit, we find Kronecker nowhere making an effort to obtain his rights.

Kronecker's studies of the nature of mountain disease was a stimulus which gave rise to researches on that subject by many other investigators, among whom I shall mention Zuntz and Loewy and A. Mosso, who came to results differing from those of Kronecker. It was, however, in Kronecker's laboratory that Loewy made the analyses of his results, and I have been a witness of the attractive scene when Mosso was introduced by Kronecker to his students to lecture on Mosso's theory of acapnia as the cause of mountain disease, a theory entirely at variance with that of his own.

Kronecker had many scientific disputes and was often energetic and perseverant in the defense of his views. But he never permitted a personal note to slip into his discussions.

Physiology lost in Kronecker a master and a leader, and numerous physiologists all over the world lost in him a noble and kind-hearted friend.

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Rockefeller Institute

SCIENTIFIC NOTES AND NEWS

Dr. A. Penck, professor of geography at Berlin; Dr. F. von Luschan, professor of anthropology in the same university, and Dr. J. Walther, professor of geology and paleontology at Halle, are among the German men of science who accepted invitations to attend the Australian meeting of the British Association. It is said that there is some anxiety as to how they shall return home. If press despatches are to be believed, several German astronomers, including Professors Kempff and Ludendorf, who had gone to the Crimea to observe the eclipse of the sun, have been taken prisoners and their scientific instruments confiscated.

The Paris Academy of Sciences has placed itself at the disposal of the national defense. This resolution having been communicated to the government, members have been placed on commissions on the subjects of wireless telegraphy, aviation, explosives, hygiene and medicine. The academy is said to be continuing its meetings. A paper was presented at the last meeting of which reports are at hand on the recent eclipse of the sun by Messrs. Baillaud and Bigourdan, of the Paris Observatory.

THE Paris Academy of Medicine has decided unanimously that all its members will place themselves at the disposal of the government for any purpose for which they may be useful to the country. It has asked to be given the necessary animals and apparatus for manufacturing and applying small-pox and antityphoid vaccines.

THE British pharmaceutical committee, which is advising the government on the question of the rise in price of various drugs, is said to be holding frequent meetings. It consists of Messrs. Edmund White, E. T. Nethercoat, C. A. Hill, John C. Umney and W. J. U. Woolcock. Information is in the hands of the committee to the effect that the prices of certain drugs are inflated by reason of the action of particular dealers.

DR. AUG. AGNEUR, formerly professor of medicine at Lyons, and recently minister of education in the French government, has become minister of marine.

MR. ADOLPH ROLLOFF, director of the State Botanical Garden in Tiflis, Russia, is visiting the botanical gardens of the United States.

AN Institute of Oceanography has been established in Spain under the direction of Professor Odón de Buen.

THE Ohio State Board of Administration has established a psychological bureau to study and care for juvenile delinquents. In addition to the chief of the bureau, whose salary is $3,500 a year, a staff of eight assistants is planned, including three psychologists, a diagnostician and a bacteriologist. Dr. Thomas H. Haines, professor of psychology in the Ohio State University, has been appointed chief of the bureau.

THE Thirteenth Intercollegiate Geological Excursion will be held in the vicinity of Daltin on October 16 and 17, under the direction of Professor B. K. Emerson. A preliminary meeting will be held at the Wendell in Pittsfield on October 16 at 7:30.

THE home of Mr. Wallace Craig, at Orono, Me., was ruined by fire on August 16. The pigeons whose social behavior was under investigation were destroyed. However, the experiments on these individual birds were practically finished, and after rebuilding and buying a new flock of pigeons for observation, Mr. Craig will write up the results of his investigation.

PROFESSOR OLIVER C. LESTER, of the University of Colorado, has been in charge of a geological survey party studying the radium deposits in the southern part of the state.

DR. J. J. TAUBERHAUS, previously assistant pathologist of the Delaware College Agricultural Experiment Station, has been promoted to be associate research plant pathologist.

DR. HAROLD C. BRYANT, assistant curator of birds in the University of California museum of vertebrate zoology, who for the past year has engaged in studying the game birds of California, has accepted a position with the California State Fish and Game Commission. Although research work on the game birds and mammals of the state will be carried on, his work will be largely educational, as the commission believes that the protection and preservation of game is more effectually furthered by an appreciation of the value of this resource than through the maintenance of a large police force. Dr. Bryant's work on game birds in the museum of vertebrate zoology will be assumed by Tracy I. Storer, M.S., of the department of zoology of the University of California.

DR. ADOLF REMELE, professor in the forest school at Eberswald, has celebrated his seventy-fifth birthday and the fiftieth anniversary of his doctorate.

DR. EUGENE KORSCHEL, professor of zoology at Marburg, has been elected rector of the university for the coming year.

DR. AUGUST GÄRTNER, professor of hygiene at Jena, has retired from active service.

"THE Nature and Control of Hunger" was the subject of two lectures at the University of Chicago on August 19 and 20, by Associate Professor Anton Julius Carlson, of the department of physiology. On August 21 Associate Professor Henry Chandler Cowles, of the department of botany, concluded his series

of illustrated lectures on "Botanical Rambles in the West," the subject of this lecture being "Our Southwestern Desert."

Dr. Thomas H. Glenn, formerly in charge of the pathologic and bacteriologic laboratories of the Northwestern University, Chicago, has been placed in charge of the clinical and Röntgen-ray laboratories now being installed at Fort Dodge.

Professor Kr. Birkeland returned to Christiania in July after a sojourn of seven months in Africa, where he continued his researches on the zodiacal light. He will return in October and continue the observations for three years.

A course of twelve lectures on the theory and practise of radio-telegraphy will be delivered by Professor J. A. Fleming at University College, London, on Wednesdays at 5 p.m., beginning on October 28.

Dr. James Ellis Gow, professor of botany in Coe College, the author of contributions on the embryology and morphology of plants, has died at the age of thirty-seven years.

We have to record somewhat late the death of Overton Westfield Price, at one time associate forester of the U. S. Forest Service, for the internal administration of which he was largely responsible during the term of office of Mr. Pinchot.

Sir John Benjamin Stone, for many years a member of the British parliament, known to scientific men for his photographs of scientific places, objects and men, has died at the age of seventy-six years.

UNIVERSITY AND EDUCATIONAL NEWS

The Medical School of Western Reserve University receives by the will of Liberty E. Holden a bequest said to be nearly one million dollars. The fund is to be known as the Albert Fairchild Holden Foundation, in memory of Mr. Holden's son.

Dr. Hermon Carey Bumpus, business manager of the University of Wisconsin, formerly director of the American Museum of Natural History, has been elected president of Tufts College.

The *Journal* of the American Medical Association states that Dr. Daniel A. K. Steele has been appointed senior dean and head of the department of surgery in the college of medicine of the University of Illinois; Dr. Charles Spencer Williamson, professor of medicine and head of the department; Dr. Charles Summer Bacon, professor of obstetrics and head of the department of obstetrics and gynecology; Dr. Julius Hays Hess, associate professor of pediatrics and head of the division of pediatrics; Dr. Norval Pierce, professor of otology; Dr. Joseph C. Beck, associate professor of laryngology and rhinology and head of the division; Dr. Oscar Eugene Nadeau, instructor in surgical pathology; Dr. A. O. Shoklee, associate professor of pharmacology; Dr. Roy L. Moodie, instructor in anatomy, and Dr. C. S. Smith, instructor in physiological chemistry.

Professor H. H. Lane, head of the department of zoology at the University of Oklahoma, has been granted a sabbatical leave of absence on half salary, to carry on research work at Princeton University. Dr. W. C. Allee, formerly instructor in zoology in Williams College, will be acting head of the department, to which he will be permanently attached as assistant professor.

Edward J. Kunze, of the Michigan Agricultural College, has been appointed professor of mechanical engineering in charge of the department of mechanical engineering at the Oklahoma Agricultural and Mechanical College.

Dr. Ernest Sachs, associate in surgery at Washington University Medical School, St. Louis, Mo., has been appointed associate profesor of surgery at the same institution.

F. L. Pickett, sometime instructor in botany at Indiana University, and for the past year research fellow at the same institution, has been appointed associate professor of plant physiology at Washington State Agricultural College.

James Clarence De Voss, M.A. (Colorado, '12), has been appointed professor of psychology and education in the Kansas State Normal School at Emporia.

DR. J. B. LEATHES, F.R.S., professor of pathological chemistry in the University of Toronto, has been offered the chair of physiology at the University of Sheffield rendered vacant by the acceptance of Professor J. S. Macdonald of the chair of physiology in the University of Liverpool.

DISCUSSION AND CORRESPONDENCE

RESEARCH ESTABLISHMENTS AND THE UNIVERSITIES

PRESIDENT WOODWARD'S address[1] contains so much of concentrated wisdom on the subject of scientific research within and without universities that no American scientist should fail to read it carefully. The part which impresses me as especially timely deals with "research in academic circles." President Woodward does not discuss the question whether research is a desirable agency in the disciplining of untrained minds, but I understand this to be the theory on which most university instruction in science is now based. The so-called "inductive method" is simply the method of research. Our science courses aim only in a minor degree to impart information; their chief aim is frankly recognized to be training in methods of discovering truth. But is the training of students in *methods* of research itself *research?* This is a subsidiary question which President Woodward's words suggest and concerning which I think we are apt to deceive ourselves.

Our larger universities, and many of our smaller ones too, point with pride to the research work which they are accomplishing. But in not a few cases this work, if inspected carefully, is found to take final shape in dissertations for the doctorate, of doubtful value as contributions to knowledge, prepared primarily not because the author had something of value to record but because he had to record something in order to get the coveted degree. The chief energies of many professors entirely competent as investigators are wholly absorbed in laboriously dragging candidates through the academic mill up to the final examination for the doctorate. Their success as research professors and the standing of their universities as centers of research is commonly estimated in numbers of doctorates conferred. See the publications of graduate schools, departmental pamphlets, and even SCIENCE (Aug. 21, 1914) with its annual list of "Doctorates conferred by American Universities."

Now is this in any true sense *research?* To coach an ambitious but mediocre mind up to the point of making a fair showing for the doctorate is the more exhausting, the more mediocre the candidate. Whatever its educational value, it certainly has little value as research. Yet this makes up a considerable part of the "research" activity of our best universities. Great sums of money are devoted to it in the form of fellowships, scholarships, buildings for laboratories and laboratory equipment for the use of advanced students. A small part of this investment devoted to research by the professors themselves unhampered by a crowd of immature and incompetent students would doubtless be much more effective in advancing knowledge.

The attempt to combine teaching with research has another indirect but evil consequence. The periods which the professor can himself devote to research are intermittent and fragmentary. This affects disadvantageously the topics selected for investigation. They too must be minor and fragmentary. Great fundamental questions requiring long continued and uninterrupted investigation can not be attacked with any hope of success by one who has only an occasional day or a summer vacation to devote to research. The necessity, too, of hunting up thesis subjects for students, small enough in scope to be handled successfully by a beginner in a limited time and yet novel enough to make a showing of originality reacts unfavorably on the professor's own work. It loses both in breadth and depth. He who in the full maturity of his powers should be doing a day's work, runs errands for boys, holds their coats and carries water. Imagine what the "Origin of Species" would have been like had it been brought forward vicariously as a series of theses for the doctor's

[1] "The Needs of Research," SCIENCE, August 14, 1914.

degree, each aiming to present a different point of view or a novel method of attacking evolutionary problems. Darwin might in that case have lived to see his pupils holding numerous professorships in widely scattered schools to the glory and delight of his university; the grateful pupils might even have honored him with a Festschrift on forty different and wholly unrelated subjects—but the world would still hold the theory of special creation!

Our universities need carefully to consider whether they are really *fostering research* in multiplying "research courses" in their graduate schools and making larger and larger bids for graduate students. In the interest of genuine research within the universities it is important that they with their estimated hundred millions annual income should not absorb the exclusively research institutions with their paltry two millions estimated annual income. It is important that the latter type of institution should persist, if only to point out the difference between giving all one's time to research and giving all one's time to training for research those who either are incapable of it or are never going to have time for it themselves, but will only repeat the endless process of getting others ready for it.

But it has been objected and will be objected again—If the university does not foster incipient research by training beginners, there will soon be no trained investigators. Is this true? Is it true, I wonder, in the case of astronomy, the oldest of sciences, the one which is almost never used as a stepping stone to the doctorate in a graduate school? Is there a dearth of workers there, of adequately trained and competent ones? Astronomy has certainly not ceased to advance in our time.

Should the university then abandon research? By no means, but it should cease to deceive itself as to what research is. It is not offering "Courses in Research" or conferring doctorates or publishing numerous papers or even building laboratories.

Many of our universities already have attached to them genuine research establishments which are making important contributions to knowledge. As a rule they receive no students and confer no degrees. They are invariably endowed; otherwise they would sooner or later be dragged into the whirlpool of teaching and forced to offer courses and degrees as bait to prospective students and would thus be turned aside from intensive and effective investigation. Some such establishments, however, have other functions which interfere more or less with investigation, such as exhibition and demonstration in museums and gardens.

The university is an entirely suitable place, in many respects the *best* place, for a research establishment; but when such establishments are founded in connection with a university, their purpose *for research* should be made very clear and their administration should be kept very distinct from both teaching and the demonstration of discoveries to the public.

W. E. Castle

August 25, 1914

CHONTAL, SERI AND YUMAN

A recent reexamination of the available evidence bearing on Brinton's old but not generally accepted finding of a genetic relationship between the Chontal (Tequistlatecan), Seri and Yuman Indian languages, confirms his judgment positively. Chontal and Seri being Yuman, are Hokan; and the Hokan family therefore now has a known extent of over 2,000 miles on the Pacific coast of America. So definite are the resemblances furnished by Chontal and Seri that they help to elucidate problems in the Hokan languages of northern California. The results of the study are now awaiting publication.

A. L. Kroeber

September 8, 1914

SCIENTIFIC BOOKS

The Microscopy of Drinking Water. By George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering, Harvard University and Massachusetts Institute of Technology. Third edition, rewritten and enlarged. New York, John Wiley & Sons. 1914. xxi + 405.

The scientific study of the microscopical organisms in their relation to potable waters

(rather than as a source of fish food) is a subject of American origin and development. It was born in the laboratories of the Massachusetts Institute of Technology, nurtured by the Massachusetts State Board of Health and the Boston Water Board, and brought to full maturity in the Mt. Prospect Laboratory of the Water Department of Brooklyn. In Boston and in Brooklyn Professor Whipple was the leading spirit in the investigation of this subject.

His admirable book on the "Microscopy of Drinking Water" was first published in 1899 and has remained the standard text upon this subject. A third edition comprehensively rewritten to include the experience of the last fifteen years is most welcome to all workers in this fascinating and practically important field.

The main objects of the miscroscopical study of water are of course first to determine the causes of odors and turbidities in water and to control the remedial measures applied to them, and second, to work out the relation of the plankton to the life of fishes. It is also of value in certain cases as an index of sewage contamination, as a measure of the processes of self-purification of streams, as an explanation of the sanitary chemical analysis, and as a means of identifying water from particular sources. Professor Whipple is doubtless correct in his conviction that "the micrology of water is going to play an increasingly important part in the science of sanitation."

The methods used for the microscopical examination of water remain essentially as they were worked out by Professor W. T. Sedgwick and Mr. George W. Rafter in 1889. Three important modifications are, however, described by Professor Whipple, the sling filter for examinations in the field, the use of a round cell for counting instead of the expensive and cumbrous oblong one and the use of the cotton disc filter which gives an admirable general idea of the total amount of plankton in a given water. A new chapter on the microscope and its uses by Dr. J. W. M. Bunker is added to the discussion of the specific methods used in water examination.

Professor Whipple's discussion of limnology is extended and amplified in many respects, particularly in regard to the estimation of dissolved gases and their effect upon plankton growth. In general the effect of various environmental conditions upon the multiplication of water organisms is admirably discussed. The diagram of plankton changes in the Genesee River is particularly striking, showing the rise first of bacteria, then of protozoa, then of rotifers and crustacea, as each group preys upon the preceding one. The reviewer must demur at one conclusion, drawn on page 215, to the effect that a curve showing seasonal variations of blue-green algæ and bacteria in Baiseley's Pond, indicates that the former are antagonistic to the latter. It is quite true that the bacteria increase in spring and fall and the cyanophytes in summer; but it seems more probable that the increase in bacteria is merely the usual fall and spring increase due to rains and thaws, which occurs in all surface waters, than that the cyanophytes have anything to do with it. The season of the year has a great many effects upon a great many things and plotting two effects against each other as if they were related has led to many errors.

The most important additions to Professor Whipple's book relate to the practical control of the growths of microscopic organisms and the obnoxious odors and turbidities which they produce. This subject was in its infancy fifteen years ago, but to-day there are three well recognized preventive or remedial procedures, stripping of the reservoir site, treatment with copper sulphate and aeration. Stripping of the reservoir of its organic soil to eliminate the food of the microorganisms has been extensively used in Massachusetts, but the report of Messrs. Hazen and Fuller in connection with the proposed application of this method to the New York water supply (from which Professor Whipple quotes extensively) leads to the conclusion that stripping can not by itself be expected to produce satisfactory results and in most cases involves a large expense of doubtful value. The destruction of the microorganisms by treating reservoir

waters with copper sulphate, Professor Whipple rightly estimates as of great usefulness, although usually as a palliative rather than a permanent remedy. Reliance must be placed in the last resort upon aeration, which changes the odoriferous essential oils produced by the microorganisms into inodorous compounds, combined with filtration for the removal of the organisms themselves. The value of this procedure has been clearly demonstrated both experimentally and on a practical scale, and Professor Whipple describes plants in operation at Rochester and Albany and New York City, and at Springfield, Mass., a view of the Springfield aerating fountain forming a very attractive frontispiece for the volume.

About a quarter of Professor Whipple's book is devoted to a systematic description of the more important genera of water microorganisms. The plates of the first edition have been made much more valuable by being colored, and five new plates have been added, one showing the results of the cotton disc filter test and the other four being photomicrographs of important water organisms. C.-E. A. Winslow

American Museum of Natural History,
New York

Essays and Studies Presented to William Ridgeway on his Sixtieth Birthday. Edited by E. C. Quiggin. University Press, Cambridge, 1913. Pp. xxv + 656, 93 illustrations.

If a commemoration volume is an index to the scope of the work done by the man it is intended to honor, the Ridgeway volume is indeed a monument to the versatility of the distinguished British scholar. The one drawback about such a work is that only a Ridgeway could adequately review it. There are, for example, 25 papers dealing with classics and archeology—two large but related fields. Then under the head of "Medieval Literature and History" come half a dozen or more important papers.

About half the work is devoted to anthropology and comparative religion. Sample articles under this section include: "The Weeping God," by T. A. Joyce; "The Serpent and the Tree of Life," by J. G. Frazer; "The Problem of the Galley Hill Skeleton," by W. L. H. Duckworth; "The Beginnings of Music," by C. S. Myers; "Kite Fishing," by Henry Balfour, and "The Outrigger Canoes of Torres Straits and North Queensland," by A. C. Haddon.

Lack of space precludes the thought of reviewing the various articles even in a summary fashion. Only two will be selected for this purpose: "The Contact of Peoples," by W. H. R. Rivers, and "The Evolution of the Rock-cut Tomb and the Dolmen," by G. Elliott Smith. As to the contact of peoples Rivers begins with the formulation of the principle that the extent of the influence of one people upon another depends on the difference in the level of their cultures. He tests the principle by applying it to a study of two complex ethnologic problems, viz.: Australian culture and Megalithic monuments. It is shown that Australian culture is not simple, but complex, this complexity being due to many elements derived from without. These elements are supposed to have been introduced at intervals by small bodies of immigrants whose culture seemed so wonderful to the lowly natives that they were able to wield a far-reaching influence, one in fact which was carried by secondary movements throughout the continent. After a time the culture of the immigrants would degenerate, leaving little that was permanent. The traces of these successive influences, however, would live in magical rites, religion, myth, and tradition. This would account for the highly complex social and magico-religious institutions of the Australians, coupled with the extraordinary simplicity and crudeness of their material and even esthetic arts.

The same principle is called into requisition to account for the presence of megalithic monuments in such widely separated parts of the earth. Megalithic culture is thus carried not by vast movements of a conquering people, but by the migration of small bodies of men, the movement being one of culture rather than of race. Such a view is certainly

in keeping with the peculiar distribution of these monuments, their comparative nearness everywhere to the sea.

In "The Evolution of the Rock-cut Tomb and the Dolmen," Elliott Smith would derive the Egyptian *mastaba* from the neolithic grave. He cites Reisner to prove how from the simple trench grave of Predynastic times there was gradually developed a type of tomb consisting of (1) a multichambered subterranean grave, to which a stairway gave access; (2) a brick-work super-structure (mastaba) in the shape of four walls enclosing a mass of earth or rubble; and (3) an enclosure for offerings in front of the brick superstructure. During the period of the Pyramid-builders the mud-brick mastaba began to be imitated in stone. Within the masonry of the mastaba, but near the forecourt, is a narrow chamber, usually known by the Arabic name *Serdab*. Here is placed a statue of the deceased, sometimes also of other members of the family and servants. The statue represents the deceased and is in communication with the outside world through a hole connecting with the forecourt, or chapel. According to Elliott Smith the dolmens scattered over the world from Ireland to Japan are but crude, overgrown and degraded Egyptian mastabas, the one feature retained being the serdab, the dwelling of the spirit of the deceased.

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BOTANICAL NOTES

A NEW NATURE BOOK

WE have had many books on "agriculture" and still more on "nature study," all of which have been more or less helpful, while being at the same time more or less unsatisfactory and it has remained for Professor J. G. Needham to prepare a book which directs the attention of the pupil to both subjects in one view with what appears to be a maximum of helpfulness and a minimum of objectionable features. He calls his book "The Natural History of the Farm" (Comstock Pub. Co., Ithaca, N. Y.) and tells in his preface that it deals with "the sources of agriculture," meaning by this the wild plants, wild animals, the virgin soil, the weather, etc., with which we deal. The idea underlying the treatment is good, and must commend itself to every scientific man. We apprehend that there will be some ultra "practical" critics who will demand more agriculture and less natural history, and yet it has been the writer's observation that just such information as is here given, such suggestions as are here made will prove to be the most helpful to the boys and girls in the country schools. Agriculture is no more all cultivation of crops, than is classical culture simply the study of Greek and Latin roots. This book breathes of the farm and of country life, of the wild things, as well as those that we have brought into our fields and stables. It is an attempt to broaden and liberalize agriculture and to bring it into relation with the things in nature. The topics of some of the chapters will show how this is done: Mother Earth, Wild Fruits of the Farm, Wild Nuts of the Farm, The Farm Stream, Pasture Plants, The Farm Wood-lot, The Wild Mammals of the Farm, The Domesticated Mammals, The Lay of the Land, Winter Activities of Wild Animals, Maple Sap and Sugar, What Goes On in the Apple Blossoms, The Clovers, Weeds of the Field, Some Insects at Work on Farm Crops, etc. Surely no boy or girl in the country could use this book without great pleasure and great profit.

A STUDY OF ASTERS

QUITE recently Charles E. Monroe has published in the *Bulletin* of the Wisconsin Natural History Society a paper on "The Wild Asters of Wisconsin," which is of more than the usual interest of local lists, or local discussions of groups of species. In his introduction the author makes some thoughtful suggestions as to "species" in general, and "species" of asters in particular. Thus he says

> The old notion of a species, as something definite, fixed and stable, nowhere breaks down more completely than when an attempt is made to apply it to the different forms of *Aster* as we find them in this country. Different species are so connected by intermediate forms that we often feel like ignoring specific distinctions and grouping two or

more species together under one name. On the other hand, to one of a more analytical bent of mind, the difference between members of a single species may appear so marked that he will be under constant temptation to separate them into still smaller subdivisions and to give to each specific rank. But, whichever course we follow, the different groups into which the genus, or a species, may be divided represent little more than particular tendencies or directions of variation, and the members of each make up a series illustrating the different stages. The word "species," as applied to our North American asters, can hardly be said to have any other significance than this.

It will startle some old-fashioned taxonomists to read the next sentence:

It does not seem a valid objection that under such a definition a single plant might be conceived as belonging to more than one species.

Notes are made of ten previous lists of Wisconsin asters, and then follows a systematic and critical discussion of the species recognized by the author. This latter is so well done that one is tempted to wish that it might be used as a model by other local botanists.

SHORT NOTES

Important phytopathological papers by G. G. Hedgcock have appeared as follows: "Notes on Some Western Uredineae which attack Forest Trees" (*Phytopath.*, III.); "Notes on Some Diseases of Trees in our National Forests" (*Phytopath.*, III.); "Injury by Smelter Smoke in Southeastern Tennessee" (*Jour. Wash. Ac. Sci.*, IV.); "The Alternate Stage of *Peridermium pyriforme*" (privately printed June 12, 1914). In the latter the conclusion is reached that the alternate stage occurs on *Comandra umbellata*.

B. F. Lutman contributes an interesting paper on "The Pathological Anatomy of Potato Scab" accompanied with ten text figures, in which he concludes that "The scab is due to the hypertrophy of the cells of the cork cambium" (*Phytopath.*, III.). The same author's "Studies on Club-root" (Bull. 175, Vt. Agr'l Expt. Sta.) will be suggestive to those who are interested in the organisms usually known as slime molds (Myxomycetes). The one here under consideration is *Plasmodiophora brassicae*, and it infests the root cells of cabbages and other cruciferous plants. It gains entrance either through the epidermis or the root-hairs, and produces cellular hypertrophy, especially of the cortical tissues.

Nuclear divisions in the plasmodium are of two types—vegetative and reduction. The vegetative divisions are peculiar in that a spireme is not formed. . . . The reduction division is one of those preceding spore formation, probably the first.

Six text figures and four plates (with 52 figures) accompany the twenty-seven pages of text.

A significant feature of the new edition of the "Genera of British Plants," by H. G. Carter (Cambridge, 1913), is the adoption of Engler's system. At the outset it must be remembered that the "plants" referred to in the title are the ferns and flowering plants. The little book (of 139 pages)

is intended to familiarize students of British vascular plants with Engler's system in its latest form, and thus to habituate British floristic students to the use of a more natural system than that to which they have been accustomed in the British floras that have hitherto appeared.

In carrying out this plan the class, ordinal and family characters are clearly given, while the genera are briefly characterized by means of analytic keys. A similar book for North America would be very useful. However, we can not approve of the use of the terms "apopetalous" and "apochlamydeous" as defined by the author (petals, or perianth "absent by reduction") even though sanctioned by Engler. Certainly "apetalous" and "achlamydeous" are sufficiently definite for the conditions of *no petals*, and *no perianth*, leaving "apopetalous," and "apochlamydeous" for the conditions of *separate petals*, and *separate perianth segments*.

Charles E. Bessey
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SPECIAL ARTICLES

THE ALLEGED DANGERS TO THE EYE FROM ULTRA-VIOLET RADIATION

During recent years there have been not a few sensational attacks upon modern illu-

minants as dangerous by reason of injurious effects of the ultra-violet radiation delivered by them. The literature of the subject is large, but unhappily most of the investigations have entirely neglected any quantitative relation between the radiation and its supposed pathological effects. One can not stigmatize an illuminant which emits ultra-violet as dangerous for this reason any more than one can declare a stove unfit for use because it is possible to burn the finger by deliberately touching it. The vital question is not whether a light source gives ultra-violet radiations, but whether it gives them of such kind, and in sufficient quantity, as to make any injury to the eye possible under practical conditions. A second point frequently neglected in the discussion of this subject has been the action of the eye itself in focusing radiation falling upon it, with the resulting effects upon the intensity of the radiation in the media of the eye. Finally a great many errors have been made and unwarrantable conclusions reached owing to the fact that in the solar spectrum the maximum intensity of radiation is in the brilliantly luminous part of the spectrum, where in addition the so-called actinic power is considerable, so that phenomena possibly having their origin in specific effects of radiation of particular wave-length become difficult to separate from those of purely thermic origin.

During more than two years past the writers have spent a large amount of their time in an investigation from a quantitative standpoint of the effects of radiation on the various media of the eye from the corneal epithelium back to the retina, and have investigated with considerable care the maladies reputed by one writer or another to be due to the specific effects of radiation. Broadly we have found that no artificial source of light used for illuminating purposes contains enough ultra-violet radiation to involve the slightest danger to the eye from its effects under any readily conceivable conditions of use, and that such pathological action as can be obtained experimentally from the ultra-violet is confined to a strictly limited region of the spectrum and obeys perfectly definite quantitative laws in its action. Incidentally we have found most extraordinary resisting power of the eye as respects radiations outside this particular range, which is in fact the whole body of radiation present in any material quantity in the energy normally received from the sun at the surface of the earth.

Our conclusions regarding these fundamental matters and respecting the various alleged pathological effects which have been charged up against radiation are appended as preliminary to the more complete publication of the methods and results of our investigations. Most of the experiments were made upon the eyes of rabbits and monkeys. An especially noteworthy experiment, however, relating to the possibility of abiotic action on the retina, was made upon a human patient affected with cancer of the eye-lids, twenty-four hours before the eye was removed. A number of crucial experiments were also made upon our own eyes. It should be especially noted that while the abiotic effects of the extreme ultra-violet on the outer eye are well defined, they are limited to a particular region and their extent in case of exposure to any given radiant can be definitely predicted and effectively guarded against.

Conclusions

The liminal exposure capable of producing photophthalmia to the extent of conjunctivitis accompanied by stippling of the cornea, is in terms of energy 2×10^6 erg seconds per square cm. of abiotic radiation of the character derived, for example, from the quartz lamp or the magnetite arc. About two and a half times this exposure, *i. e.*, 5×10^6 erg seconds per square cm., is required to produce loss of corneal epithelium.

The abiotic action on the cornea and conjunctiva produced by any radiating source follows the law of inverse squares and is directly proportional to the total abiotic energy received. It can therefore be definitely predicted from the physical properties of the source.

After exposure of the eye to abiotic radiations there is a latent period before any effects,

clinical or histological, become perceptible. This period of latency in a general way varies inversely with the severity of the exposure, but a theoretical latency of 24 hours or more corresponds to an exposure entirely subliminal.

The combined effect of repeated exposures to abiotic radiations is equivalent to that of a continuous exposure of the same total length, provided the intermissions are not long enough to establish reparative effects. Approximately, the exposures are additive for intermissions of somewhat less than 24 hours. Exposures of one third the liminal given daily begin to show perceptible effect only after about six exposures. Daily exposures of one sixth the liminal repeated over long periods produce no effect whatever, except to give the external eye a degree of immunity against severer exposures. Actual abiotic damage to the external eye renders it temporarily more sensitive to abiotic action.

Abiotic action for living tissues is confined to wave-lengths shorter than 305 $\mu\mu$, at which length abiotic effects are evanescent, while for shorter wave-lengths they increase with considerable rapidity.

For the quartz arc and the magnetite arc the abiotic activity of the rays absorbed by the cornea is eighteen times greater than those which are transmitted by it. To effect the media back of the cornea requires, therefore, at least eighteen times the liminal exposure heretofore mentioned.

Even with exposures as great as one hundred and fifty times the liminal for photophthalmia the lens substance is affected to a depth of less than 20 μ, and this superficial effect undergoes in the rabbit complete repair. Such enormously intensive exposures, which we obtain with the magnetite arc and double quartz lens system may completely destroy the corneal epithelium, corpuscles and endothelium. The corneal stroma may be strongly affected by waves shorter than 295 $\mu\mu$, which it completely absorbs, but is very slightly affected by the remaining abiotic radiation.

The histological changes produced by abiotic radiation are radically different from those produced by heat, and the cell changes are best seen in flat preparations of the lens capsule. The most characteristic change is the breaking up of the cytoplasm into eosinophilic and basophilic granules.

Changes in the lens epithelium like those following abiotic action, including the formation of a "wall" beneath the pupillary margin, are not exclusively characteristic of abiotic action, but may be produced by ordinary chemical reagents. They are, therefore, characteristic not of abiotic action alone, but of chemical action in general.

Abiotic radiations certainly do not directly stimulate, but, on the contrary apparently depress mitosis. Their action in this respect also is materially different from that of heat.

The lens protects completely the retina of the normal eye even from the small proportion of feebly abiotic rays which can penetrate the cornea and vitreous.

Experiments on rabbits, monkeys and the human subject prove that the retina may be flooded for an hour or more with light of extreme intensity (not less than 50,000 lux), without any sign of permanent injury. The resulting scotoma disappears within a few hours. Only when the concentration of light involves enough heat energy to produce definite thermic lesions is the retina likely to be injured.

The retina of the aphakic eye, owing to the specific and general absorption of abiotic radiations by the cornea and the vitreous body, is adequately protected from injury from any exposures possible under the ordinary conditions of life, even without the added protection of the glasses necessary for aphakic patients.

To injure the cornea, iris, or lens, by the thermic effects of radiation, requires a concentration of energy obtainable only under extreme experimental conditions.

Infra-red rays have no specific action on the tissues analogous to that of abiotic rays. Any effect due to them is simply a matter of thermic action, and such rays are in the main absorbed by the media of the eye before reaching the retina.

Actual experiments made on the human eye

show conclusively that no concentration of radiation on the retina from any artificial illuminant is sufficient to produce injury thereto under any practical conditions.

Eclipse blindness, the only thermic effect on the retina of common occurrence clinically, is due to the action of the concentrated heat on the pigment epithelium and chorioid, this heat being almost wholly due to radiations of the visible spectrum, within which the maximum solar energy lies.

The abiotic energy in the solar spectrum is a meager remnant between wave-lengths 295 $\mu\mu$ and 305 $\mu\mu$, aggregating hardly a quarter of one per cent. of the total. At high altitudes and in clear air it is sufficient to produce slight abiotic effects such as are noted in snow blindness and solar erythema, the former only occurring with long exposures under very favorable circumstances and the latter being in ordinary cases complicated by an erythema due to heat alone. The amount of abiotic energy required to produce a specific effect in solar erythema is substantially the same as that required for mild photophthalmia.

Erythropsia is not in any way connected with the exposure of the eye to ultra-violet radiations, but is merely a special case of color fatigue temporary and without pathological significance.

Vernal catarrh and senile cataract we can find no evidence for considering as due to radiations of any kind.

Glass blowers' cataract, often charged to specific radiation, ultra-violet or other, we regard as probably due to the overheating of the eye as a whole with consequent disturbed nutrition of the lens.

Commercial illuminants we find to be entirely free of danger under the ordinary conditions of their use. The abiotic radiations, furnished by even the most powerful of them, are too small in amount to produce danger of photophthalmia under ordinary working conditions even when accidentally used without their globes. The glass enclosing globes used with all practical commercial illuminants are amply sufficient to reduce any abiotic radiations very far below the danger point.

Under ordinary conditions no glasses of any kind are required as protection against abiotic radiations. The chief usefulness of protective glasses lies not so much in their absorption of any specific radiations, as in their reducing the total amount of light to a point where it ceases to be psychologically disagreeable or to be inconveniently dazzling. Glasses which cut off both ends of the spectrum and transmit chiefly only rays of relatively high luminosity, give the maximum visibility with the minimum reception of energy. For protection against abiotic action in experimentation, or in the snow fields, ordinary colored glasses are quite sufficient.

So far as direct destruction of bacteria within the cornea or any other tissues of the body is concerned, abiotic radiations possess no therapeutic value. This is due to the fact that abiotic radiations that are able to penetrate the tissues are more destructive to the latter than to bacteria.

F. H. VERHOEFF,
LOUIS BELL

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

BY invitation of Brown University, the twenty-first summer meeting of the society was held at that institution on Tuesday and Wednesday, September 8–9, in connection with the celebration of the one hundred and fiftieth anniversary of the founding of the university. Two sessions were held on Tuesday and a morning session on Wednesday, the attendance including fifty-two members. President Van Vleck occupied the chair at the morning sessions, being relieved by Vice-president L. P. Eisenhart at the Tuesday afternoon session. New members were elected as follows: Mr. L. K. Adkins, University of Minnesota; Dr. Lennie P. Copeland, Wellesley College; Mr. J. W. Cromwell, Jr., Washington, D. C., High Schools; Professor Tsuruichi Hayashi, Tôhoku Imperial University, Sendai, Japan; Professor C. I. Palmer, Armour Institute of Technology; Mr. G. A. Pfeiffer, Columbia University; Mr. P. R. Rider, Yale University; Dr. Alfred Rosenblatt, University of Cracow; Miss Caroline E. Seely, Columbia University. Eleven applications for membership were received. It was decided to hold the annual meeting about January 1, the exact date to be so fixed that those who wish

may attend the winter meeting of the Chicago Section and the meeting of Section A of the American Association, as well as the annual meeting. At the latter meeting, which will be held in New York, President Van Vleck will deliver his presidential address.

A committee was appointed to arrange for holding the summer meeting of 1915 at San Francisco. It was decided to issue only the List of Officers and Members next year, in place of the usual Annual Register.

The authorities of Brown University extended a lavish hospitality to the society. The morning session on Tuesday opened with an address of welcome by Chancellor A. B. Chace. Professor N. F. Davis entertained the members and ladies at tea in the John Carter Brown Library on Tuesday afternoon, and at luncheon in Rockefeller Hall on Wednesday. The university gave a dinner in honor of the society at the University Club on Tuesday evening, the occasion concluding with a cordial address by President Faunce and an interesting account by Professor Carl Barus of the "Historical development of the modern theory of physics." A vote of thanks was tendered to the university and its officers for their generous hospitality. Wednesday afternoon was devoted to an excursion to Newport.

The following papers were read at this meeting:

F. M. Morgan: "A plane cubic Cremona transformation and its inverse."

L. P. Eisenhart: "Conjugate systems with equal tangential invariants and the transformation of Moutard."

C. E. Love: "Singular integral equations of the Volterra type."

O. E. Glenn: "Modular invariant processes."

L. E. Dickson: "Invariants, seminvariants and covariants of the ternary and quaternary quadratic form modulo 2."

L. E. Dickson: "The points of inflection of a plane cubic curve."

L. E. Dickson: "A fundamental set of modular invariants of the system of the binary cubic, quadratic and linear form."

L. E. Dickson: "Invariants in the theory of numbers."

F. B. Wiley: "Proof of the finiteness of the modular covariants of a system of binary forms and cogredient points."

E. V. Huntington: "The theorem of rotation in elementary dynamics."

R. D. Beetle: "Congruences associated with a one-parameter family of curves."

G. C. Evans: "The non-homogeneous parabolic differential equation."

R. A. Johnson: "The conic as a space element."

W. A. Hurwitz and L. L. Silverman: "On the consistency and equivalence of certain definitions of summability."

Maxime Bôcher: "The method of successive approximations for linear differential systems."

Maxime Bôcher: "The smallest characteristic numbers in a certain exceptional case."

B. H. Camp: "On the series obtained by termwise integration."

G. A. Miller: "On the ϕ-subgroup of a group."

T. E. Mason: "On functions transcendentally transcendental with respect to a given realm of rationality."

T. E. Mason: "Mechanical device for testing Mersenne numbers for primes."

H. S. Vandiver: "On Bernoulli's numbers, Fermat's quotient and last theorem."

L. C. Karpinski: "An early algorism."

H. S. White: "Triple systems on 31 letters; a reconnoissance."

L. D. Cummings: "The trains for 42 non-congruent triple-systems on 15 elements."

J. H. M. Wedderburn: "On matrices whose coefficients are entire functions."

E. R. Smith: "A problem in the fitting of polynomial curves to certain kinds of data."

H. R. Kingston: "Metric properties of nets of plane curves"

G. D. Birkhoff: "The iterated transformation of a plane into itself."

W. B. Fite: "Prime power groups in which every commutator of prime order is invariant."

Edward Kasner: "Transversality for double integrals in the calculus of variations and for contact transformations."

Edward Kasner: "The decomposition of conformal transformations into factors of period two."

R. G. D. Richardson: "A new boundary value problem for linear hyperbolic differential equations of the second order."

Joseph Rosenbaum: "Mixed linear integral equations over a two-dimensional region."

D. C. Gillespie: "Cauchy's definition of a definite integral."

The next regular meeting of the society will be held at Columbia University on October 31. The San Francisco Section will meet at the University on October 24.

F. N. Cole,
Secretary